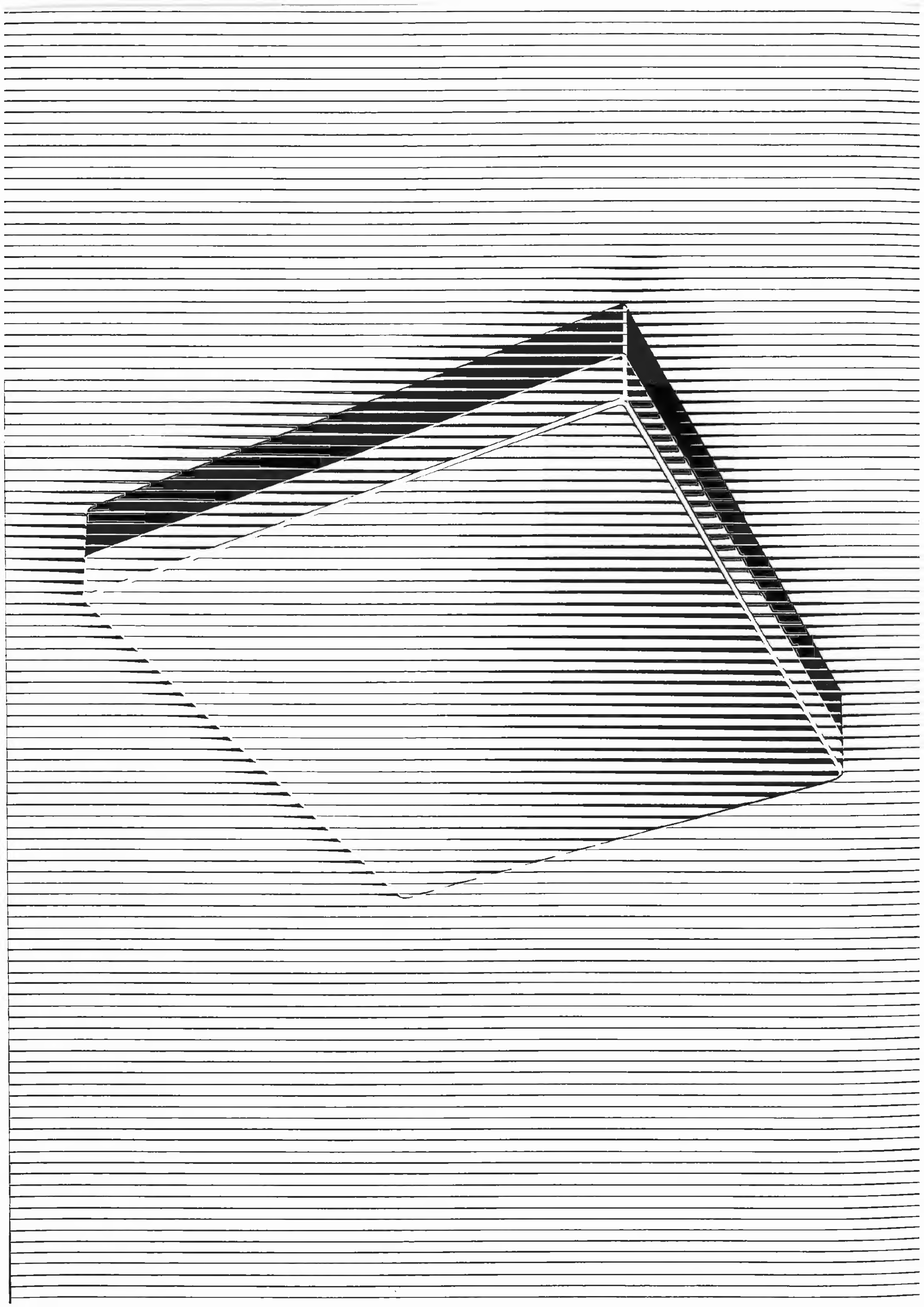
LIGHTING JOURNAL

wall-mounted lighting in Edinburgh
designing more effective lighting
Thorn Q-File control system

THORN

number two/spring 1969/published by BRITISH LIGHTING INDUSTRIES LIMITED



LIGHTING JOURNAL

number two/spring 1969

Cover picture shows the Middle Temple Hall in London relighted by BLI using a multiplicity of light sources on dimmer control. Special techniques were used to reveal the unique double hammer beam ceiling.

Published by British Lighting Industries Limited
(Atlas Mazda Ediswan Ekco lighting products)
Thorn House Upper Saint Martin's Lane
London W C 2. Printed by The Broadway Press Ltd
London England

Two of the articles in this second issue of *Lighting Journal* are concerned with the use of fittings having an asymmetrical distribution. The two applications are very different in nature, and the fittings are used for different reasons in the two installations.

For street lighting in Edinburgh asymmetrical fittings have been used in wall-mounted installations chiefly to avoid the necessity for lighting columns which would be considered unsightly (and perhaps incongruous) in the Royal Mile and obtrusive on a thoroughfare as handsome as Princes Street. Lighting of this kind is a far cry from orthodox street lighting technique but the article shows that wall-mounted installations can be effective, especially when associated with a high efficiency light source such as the newly-developed linear mercury halide lamp.

In the case of the interior lighting at the Westminster Bank in London, the asymmetrical distribution was chosen for quite different reasons, namely, to produce an acceptable flow of light across the offices and give good modelling, and yet provide adequate illumination at working positions.

It is coincidental that two developments of this kind should take place at the same time, but when associated with new light sources and new ideas about the way light should be used they serve to emphasize the fluidity in the present state of the lighting art and the wide range of possibilities that lie before the lighting designer.

2/

wall-mounted lighting in Edinburgh

by G K Lambert BSc(Eng) ACGI DIC CEng AMIMechE MIEE FIllumES

A new street lighting installation in Princes Street, Edinburgh, was commissioned on 6 December 1968. It is notable for a number of reasons: it extends the technique of wall-mounted lighting to suit the special requirements of this street; it uses a new type of lamp in a specially designed lantern; it sets a new standard of city centre lighting giving economically an average of over 100 lux (10 lm/ft^2) of good colour light. This is well beyond the recommendations of the recently issued BS Code of Practice on the Lighting for Town and City Centres and Areas of Civic Importance but is appropriate for high prestige locations such as Princes Street.

Use of wall-mounted lighting

Wall-mounted lighting in town and city centre areas has several advantages, the most important being that the visual scene is relieved of much of the clutter of street furniture. Buildings, particularly those of historic or architectural importance, can be seen more as they were built in the days before the growth of modern traffic. The lighting equipment must, of course, be mounted discreetly on the building front. Savings in cost and reduced obstruction of pavements are also welcome.

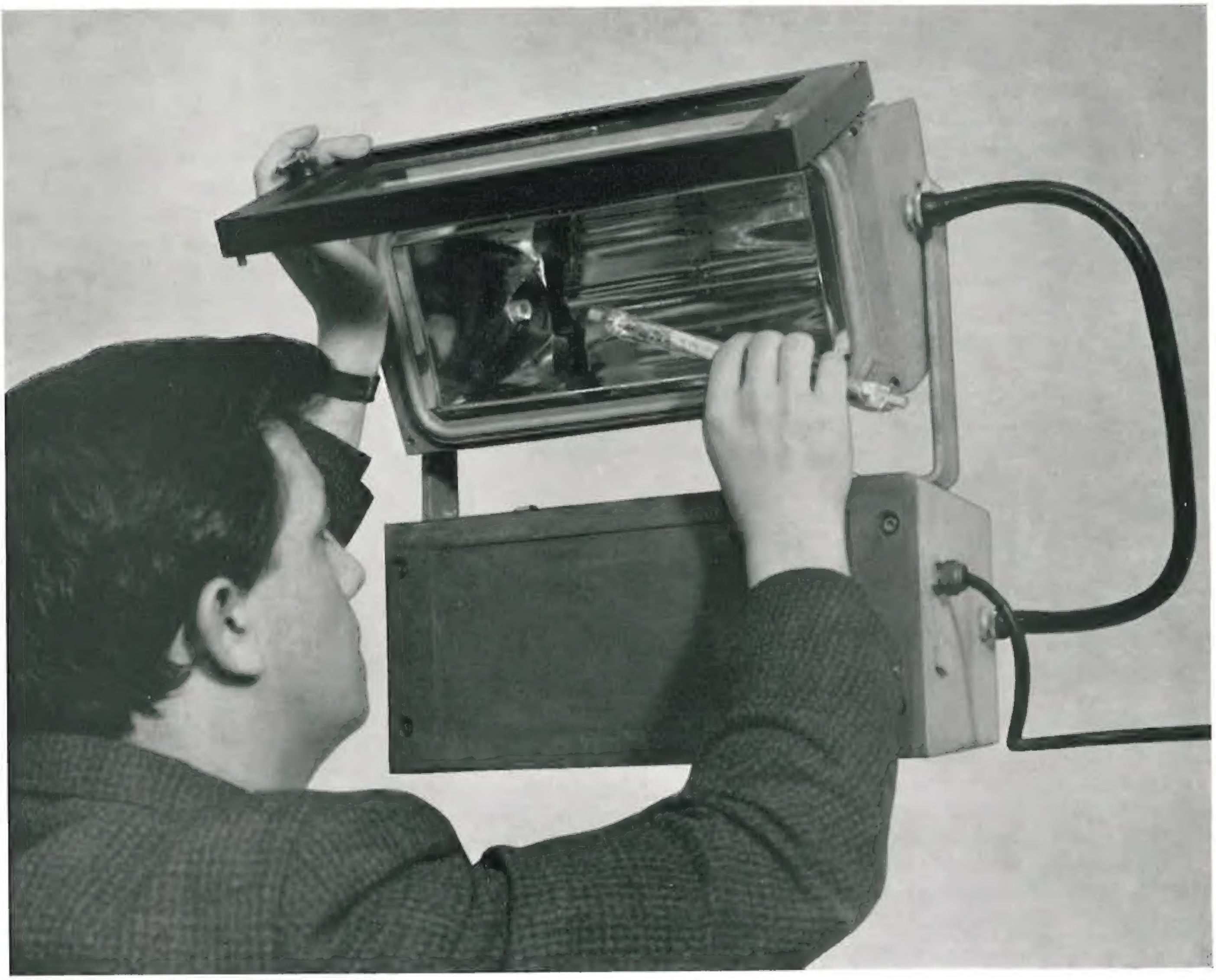
The lighting equipment can be conventional street lanterns or floodlights and the choice depends on the location.

A city rich in historic buildings

Edinburgh is particularly rich in historic buildings and it is not surprising that the technique of wall-mounted lighting has been adopted and developed here.

The heart of old Edinburgh, the Royal Mile, runs from the Castle through Lawnmarket, High Street and Canongate to the Palace of

G K Lambert is with the Lighting Development Group, BLI laboratories, Leicester.



Holyroodhouse. Following a successful trial in 1964 it is now lit throughout by Atlas tungsten-halogen projectors mounted on the face of the buildings. The projector beams are directed across the road at an angle of about 45° to the downward vertical. The mounting height is 45ft and the spacing, varied to suit the buildings, is up to 60ft. The projectors are arranged in 'pairs opposite' formation in the wider sections where the width between buildings is up to 85ft, with 'staggered' arrangement in the narrower stretches where the width falls to 30ft. Nearly all the projectors use 750W lamps but a few are of 1 500W.

This installation is very successful, the projectors being inconspicuous by day, and by night flooding the whole area with warm light at an average of 40 lux (4 lm/ft^2) with good uniformity. Because the mounting height is greater than usual and because of the direction of the light, glare is negligible in spite of the high intrinsic brightness of the source (See picture on page 9).

Special requirements of Princes Street

For years there has been pressure to eliminate the lighting columns from Princes Street. This wide thoroughfare with smart shops, hotels, gardens and monuments provides along its length a world famous panoramic view. This extends from Calton Hill with the National Monument and Nelson Monument sweeping past Salisbury Crags

Figure 1 The Mazda linear mercury halide lamp with its associated reflector lantern.

and Arthur's Seat to the Mount, Princes Street Gardens and the Castle. Typical features include the Sir Walter Scott Monument and the Royal Scottish Academy. The street is also a traffic route and carries very dense traffic at certain times of the day, being busy right into the night. It presents a lighting problem that had not been satisfactorily solved in the past. The 140W sodium lanterns previously in use were mounted in pairs on the old tramway columns along the centre of the road. They were frankly for traffic, without regard for amenity, a revulsion against an earlier symbolically decorative lighting which was not effective for traffic.

It was naturally desired to try the same technique as in the Royal Mile. Experiments had been carried out with varying but moderate degrees of success. Two problems arose. The cost of electric power, even with tungsten-halogen lamps giving 20 lm/W conversion efficacy, is high relative to that for comparable discharge lamp lighting. The extra width and the absence of buildings along most of the south side of Princes Street, where it is open to the gardens, made even more powerful sources desirable.

Opportunely, a suitable new light source was under development in the research and engineering laboratories of British Lighting Industries at Leicester. Following a successful trial of this in February 1967, using modified tungsten-halogen fittings, development was hastened and the whole of Princes Street has now been lit with the Mazda 750W MBIL/H lamp incorporated in specially designed area flood-lighting projectors.

The Mazda 750W MBIL/H lamp and floodlight

Since the inception of mercury discharge lamps in the 1930s effort has been directed towards improving the colour of the light. The radiation from a mercury arc discharge is not a continuum of gradually changing wavelength light that can be spread by a prism into a rainbow spectrum. Instead it is mainly concentrated at four wave-lengths in the yellow-green region of the visible spectrum and two wavelengths in the ultra-violet.

The colour-corrected mercury discharge lamp in common use for street lighting converts ultra-violet radiation to red light by means of a fluorescent phosphor coating on the outer bulb of the lamp. The alternative is to add other metals to the arc. Metals that have been tried include cadmium and zinc. Other useful additions could be thallium, providing light that is mainly green; indium, blue; sodium, yellow; thorium or gallium, mainly white. These have too low a vapour pressure to contribute significantly to the spectrum of the arc discharge. By introducing them in the form of halides – usually iodides – dissociation under the conditions of the interior of the arc can result in a higher vapour pressure of the metals there, increasing their contribution to the spectrum from the discharge.

Out of the arc the metals recombine with the iodine before coming in contact with the wall of the arc tube. This protects the arc tube from attack by highly reactive material such as sodium. It is necessary to maintain the temperature of the least hot part of the arc tube to a temperature that prevents the halides condensing out. In the conventional lamp the outer bulb plays a major part in conserving heat where it is needed. This makes the lamp bulky; the 'focal length' of the light control system has to be larger than otherwise necessary, making the lanterns themselves much larger. However, by careful lantern design the required arc tube temperature can be maintained without an outer bulb.

At first glance the lamp is similar in appearance to the 1 500W tungsten-halogen lamp. It is in the form of a fused silica tube of 14mm overall diameter and 254mm length. But compared with the 33 000 lumen output of the tungsten-halogen lamp it produces 60 000 lumens and power consumption is reduced by half. The metal iodide

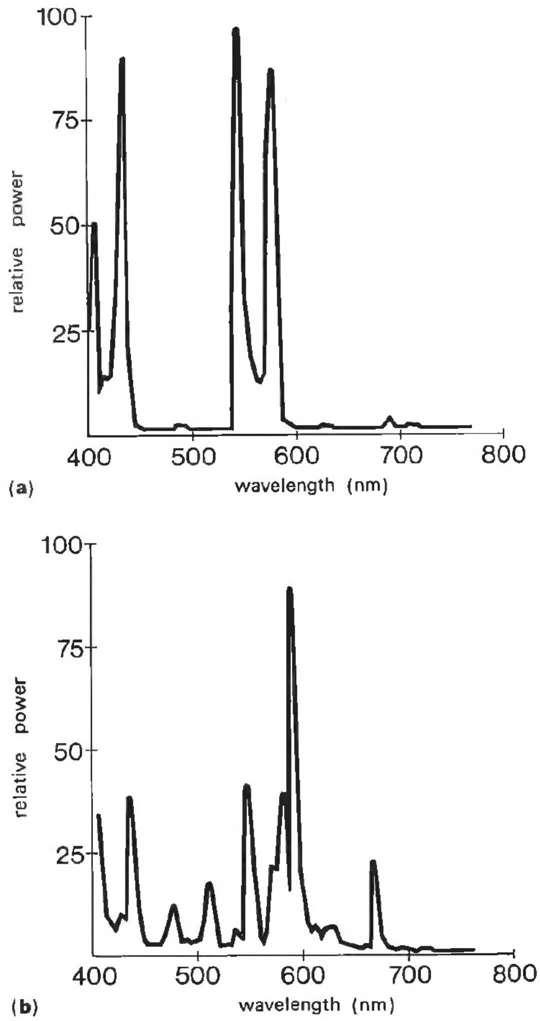


Figure 2 Spectral distribution of power from (a) the high pressure mercury vapour lamp (MB/U) and (b) the linear mercury halide lamp (MBIL/H)

additives have been selected to provide and maintain throughout life light of good colour both in appearance and colour rendering: the appearance of the light is whiter than that of the tungsten-halogen lamp. When the lamp is cold the iodides condense on the walls giving it a somewhat cloudy appearance.
A reflector lantern of a size similar to that of the tungsten-halogen floodlight serves to provide the right thermal environment, maintaining the wall temperature at an adequate value without overheating the seals at the ends where the leads enter the lamp.
The lamp operates at 475V (arc voltage) with a current of 1.8A. To ensure lamp starting and stability on run-up a high reactance

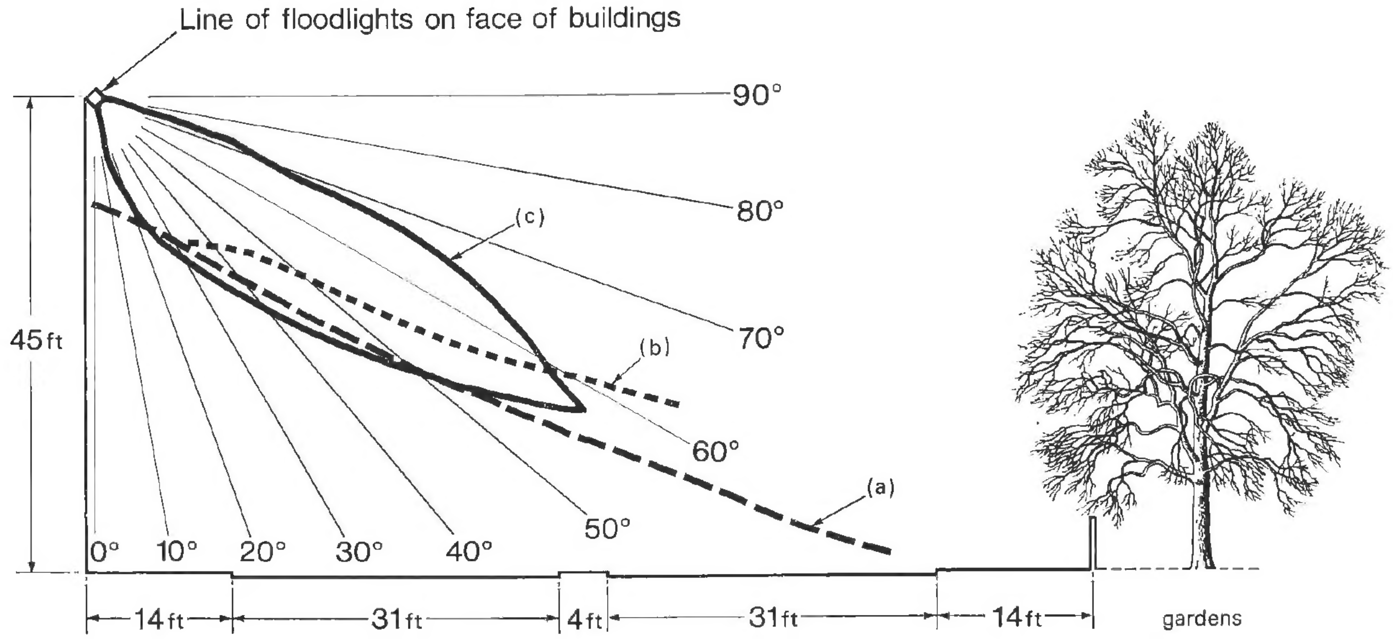
Light characteristics	
Initial conversion efficiency	90 lm/W
Lighting design lumens	60 000 lumens
Chromaticity co-ordinates	x=0·386
	y=0·372
Electrical	
Supply volts	240V
Mains current	
(running)	4·7A
(starting)	5·7A
Lamp volts	475V
Total circuit watts	900W
Circuit p.f.	0·8
Life	3 000 hours

Data for the Mazda linear mercury halide lamp

transformer system is used similar to that for sodium lamps. The transformer open circuit voltage is 1 100V. Additional safety precautions have been taken because of this. The transformer and power factor correction capacitors are totally enclosed in a finned aluminium alloy box from which the high voltage leads to the lamp pass in a flexible PVC covered conduit to the lantern. Normally the control gear box forms the base of mounting for the floodlight but the units can be separate if needed. An interlock on the lantern cover prevents access to the lamp until the mains supply is switched off and the interlock key released. When several floodlights are connected to one supply point the key from this is needed to open these floodlights but will not open those on another circuit.

Choice of light distribution and reflector design

To provide uniform illumination over an area the intensity required varies as 'secant cubed' of the angle to the downward vertical. From directly downwards to angles of about 30° the increase is slow, but after this the increase becomes ever more rapid. From area floodlighting experience it has been found reasonable to light an area extending from the point below the lantern to a distance of twice the height of the lantern away. At angles above 64° to the downward vertical the intensity should fall off rapidly.
In practice a reasonable approximation is acceptable. If a group of lanterns is mounted at one position and spread in azimuth at say 60° intervals, there is a build up of illumination directly below: for uniformity the downward intensities need to be reduced. On the other hand, if a line of lanterns is used, as in Princes Street, the overlap between adjacent beams depends on the spacing and is greater towards the far side of the road: the intensities at around 60° can then be reduced. It was decided to minimise the amount of light falling on to the adjacent buildings to avoid patches of light unrelated to their architecture or diminishing the effect of shop-window lighting or floodlighting.
As regards reflector design the source can be considered to be a rod of 0.2in diameter ×7.75in long, uniformly bright in all directions.



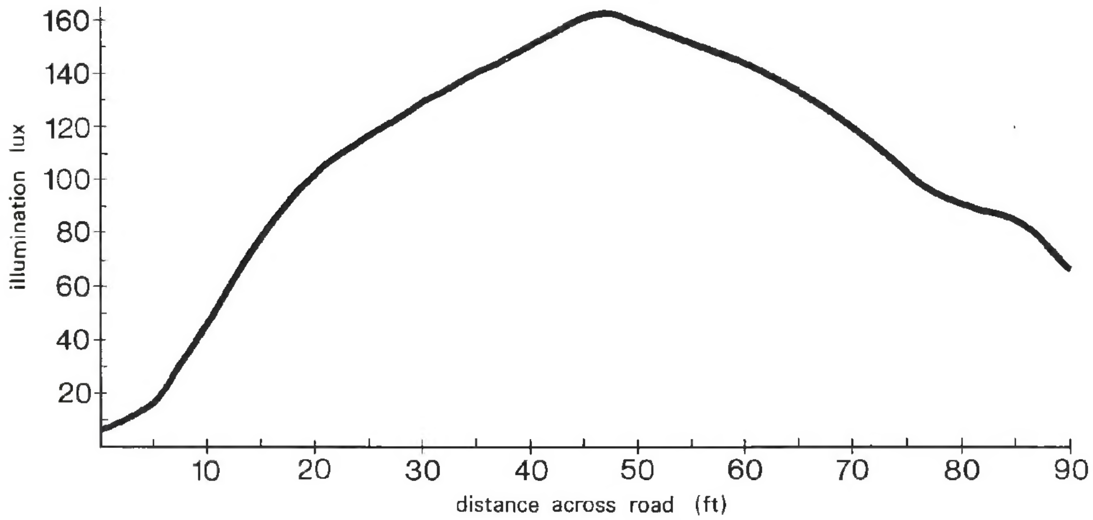


Figure 3 Cross-section of Princes Street showing vertical plane polar curves of light intensity distribution:

(a) an indication of the "sec³" distribution required if a single floodlight only is contributing to illumination.

(b) modified sec³ curves allowing for build up by lateral spread from adjacent floodlights in a row.

(c) curve of linear mercury halide floodlight as aimed in Princes Street.

A graph of average illumination along the road, against distance across, is shown beneath; this is for 40 ft. spacing of lanterns.

Design is then a matter of starting behind the lamp, say 0.75in from its axis, and proceeding round in each direction building up the reflector contour and compiling a balance sheet of light flux. The parts of the reflector below and round the back of the lamps are inclined to such an angle that they are flashed when viewed at about 60 – 63° to the downward vertical, with a 'cut-off' at 64°. The upper flank will be curved more strongly to build up intensities at angles below the beam until the edge of the reflector is reflecting light almost directly down. Although the process is simple it is lengthy as small steps have to be taken: it has to be repeated several times to get the optimum result. For this reason and to improve accuracy an electronic computer was used. It was then possible to take account of the actual structure of the lamp arc and to explore the effect of tolerances in lamp position. The ends of the reflector are closed by specular flat sloping ends which augment the peak intensity and reduce the lateral spread of the beam.

Installation

The lanterns are mounted at about 45ft height and at a spacing varying from 30ft to 50ft to suit the architecture of the buildings. The latter are not uniform and the street varies in width. In some sections the upper stories are set back and here the lanterns are brought as far as possible into line by means of an extension bracket. Usually the control gear box is mounted at first floor level and located in a convenient recess in the face of the building or hidden by a balcony or

some similar feature. The high voltage leads are of black plastic covered mineral insulated cable running vertically or horizontally and dressed flat to the building surface so that they are unnoticeable, as are many of the projectors. Only in the case of Register House has it been decided not to fix lanterns; the adjacent section of the road is covered by projectors on the GPO building opposite.

Additional projectors are used, aimed obliquely, to cover major intersections and to carry the lighting 'round the corner' until taken over by the adjacent street lighting. Occasional floodlights are added opposite roads running in from the south. The old tramway columns and conventional street lighting equipment have been cleared away.

Visibility in all cases excellent

The installation has been studied in wet and dry weather, travelling each way along the street and also as a pedestrian on the pavement both on the near side and opposite the lighting. The balance between the different factors contributing to visibility varies considerably for the different conditions, but with the high ambient light level and good backgrounds visibility is in all cases excellent. For most viewpoints features are seen by surface detail.

For observers facing the light from the opposite pavement, modelling and shadows are inevitably somewhat harsh, but less so than for many accepted installations such as, e.g., where a single high mast is used. This is because, although the lantern beams are directed across the road, they are of wide lateral spread and there is adequate illumination on the fronts and backs of vehicles. Pedestrians some 100 yards away will probably be seen mainly in silhouette from the south pavement, but for the driver surface detail of other vehicles and pedestrians is fully visible in good colour. The variety of colour in modern cars and clothing enlivens the scene; this will be really pleasant in summer when the leaves are on the trees. Comment has been made that more light could have been allowed on the buildings

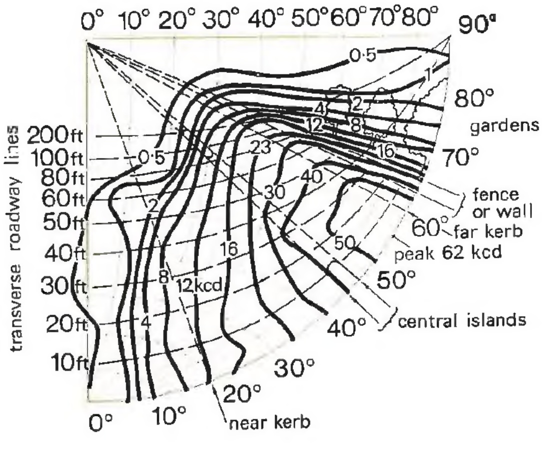


Figure 4 Isocandela diagram for floodlight as aimed, with kerb lines and transverse roadway lines added.

and near side pavement, but most of the street has shop window lighting till late at night. Floodlighting is planned for some of the buildings. It would seem that single side lighting has successfully solved the problem of lighting Princes Street.

Future

This form of lighting is ideally suited to high prestige city centre areas, particularly large squares where some light will come from the far side to soften shadows. The equipment is small enough to be unnoticeable and, particularly with its square lines, need not be detrimental to the appearance of buildings. Where there are gardens in the middle of a square and it is desired to keep them dark, the projectors could be mounted on poles with the beams directed towards the buildings, combining roadway lighting with a degree of building floodlighting. For many streets, where mounting positions are available on both sides and where they are not so wide or important as Princes Street, a lamp of lower light output will be adequate.
The present lamp is suitable also for lighting large areas to a lower intensity, for example in the neighbourhood of high flats. This probably is the most economic way of doing this due to the small number of units to be serviced.

Acknowledgments

The installation was planned and erected by the Edinburgh Corporation Lighting Department under the direction of Mr. F. Millington. His co-operation in making the partially completed installation available for appraisal, and permission to take photographs is gratefully acknowledged.

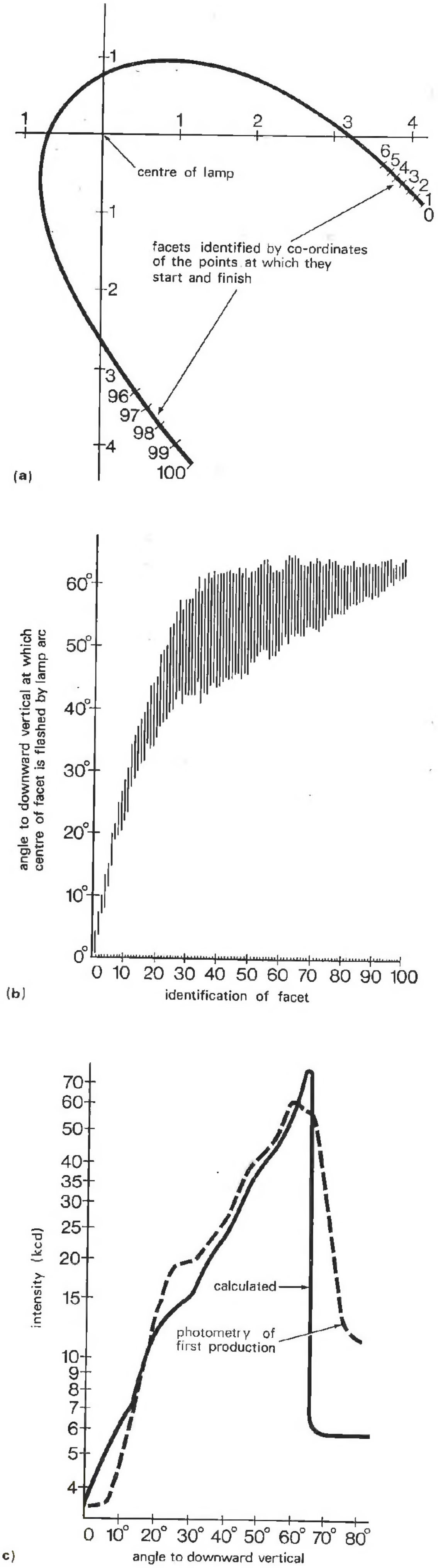
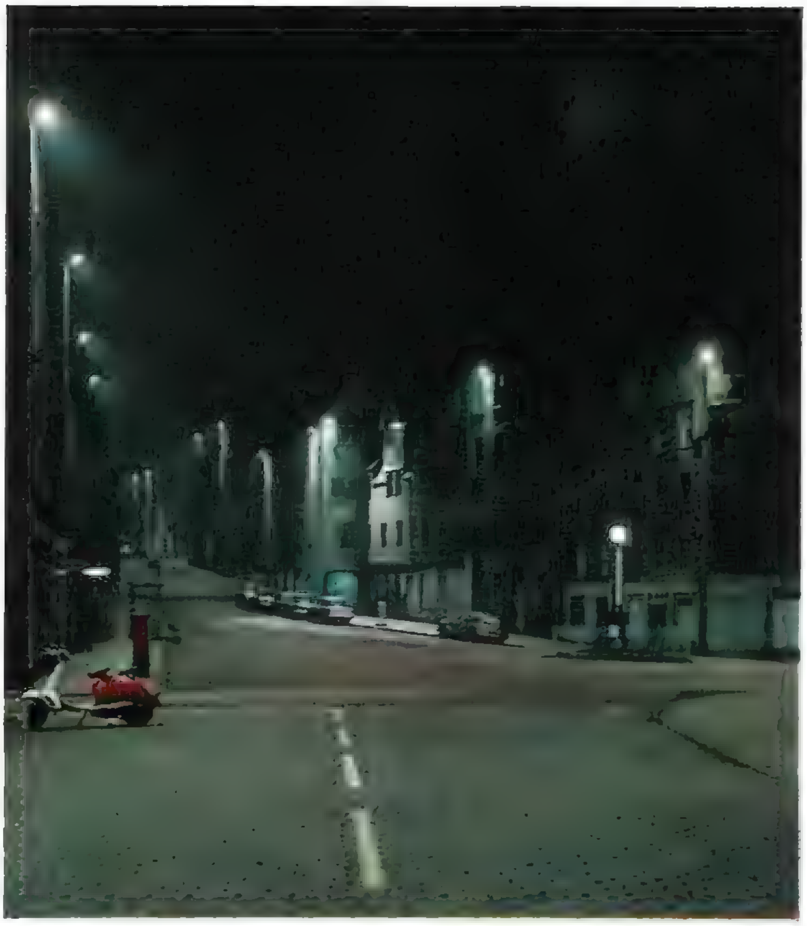


Figure 5 Computer analysis of reflector design:

(a) reflector contour divided into facets.

(b) graphical representation of flashing of facets based on computer calculation.

(c) comparison of calculated and photometered curves of light intensity distribution; the difference is mainly due to the addition of the sloping end reflectors.



Alongside Wall-mounted Atlas tungsten-halogen lighting in the Royal Mile.

Below Princes Street, Edinburgh, lit by Mazda linear mercury halide lamps.

Atlas asymmetrical fittings in Westminster Bank computer centre.

designing more effective lighting

by W K Lumsden MIllumES

Present practice in lighting design is to determine by a simple calculation the number of fittings of a given type required to produce a specified illumination on a working plane. The lumen method of calculation is generally used and this calls for the use of a utilisation factor (coefficient of utilisation). The utilisation factor is defined as the proportion of the bare lamp output which reaches the horizontal working plane, both directly from the fittings and indirectly by inter-reflection.

The lumen method is simple to use and is consequently very popular with lighting designers; it has, however, some limitations. For example, in an office 50ft × 20ft with a 10ft ceiling and light decorations the utilisation factor for an Atlas enclosed prismatic KGP fitting would be 0.49, indicating that 49% of the bare lamp flux would reach the working plane. Yet the total light output of the fitting is 66% of the bare lamp flux. It is clear from this that the lumen method of calculation using utilisation factors is in this case describing the performance of only 75% of the light emitted by the fitting, and gives no guidance as to the effect that the remaining 25% of the light will produce when it reaches the walls and ceiling.

Importance of the Glare Index

In addition to the lumen calculation, a simple computation may be made of the glare index produced by a general lighting installation, to determine the degree of direct discomfort glare to be expected. The Glare Index produced by the IES Limiting Glare Index System for a general lighting installation depends on, inter alia, the BZ classification of the fitting used. The lower the BZ classification the less light is emitted sideways and, generally, the lower is the Glare Index for the installation.

The Glare Index required is often specified without the realisation that this determines not only discomfort glare from the lighting fittings but also the appearance of the room. In conventional lighting installations the fitting with the lower BZ classification will impart a lower brightness to the walls. The rigid application of the Glare Code without regard to other factors will, therefore, dictate the luminance pattern in an interior without that pattern and its effect having been first considered and found suitable.

There is clearly room for improvement in lighting design to establish more precisely where all the light emitted by the fitting is going, and

W K Lumsden is Chief Lighting Engineer, British Lighting Industries.

what effect this light will have on the room surfaces in creating the visual environment. Of greater importance, perhaps, is the need to establish at an early stage of design the lighting effect to be produced. The effect of the lighting in this context is taken to include not only the luminance patterns within the room, but also the effect on people and objects in the room, i.e., how they appear under the lighting and whether shape, texture and colour are clearly revealed. These are subjective effects and, in addition, the designer should consider the effectiveness of the lighting installation in producing illumination at the working position. Tests carried out on a number of conventional lighting installations in fully furnished and occupied rooms indicate that the working point illumination is well below the average design value when the obstruction of the worker himself is taken into account. Measurements taken suggest that the difference in illumination values between the average in an unoccupied office and the illumination values at occupied working positions may be as great as 3 to 1.

Advantages of asymmetrical fitting

There is, then, considerable scope for improving our design standards simply by approaching each project with a full knowledge of the fitting performance and the lighting needs. There is, however, some limitation with conventional fittings at present available as these are designed to criteria that are not necessarily related to the effect they will produce in a real installation. For this reason BLI has recently introduced into its range of fittings an asymmetrical fitting which is designed:

(1) To produce a predetermined luminance pattern on room surfaces.

(2) To give more effective lighting of the working point by directing light across the office, rather than by direct lighting downwards, when desks are appropriately positioned.

(3) To introduce a flow of light into a room from window wall to interior with the aim of improving modelling of people, etc.

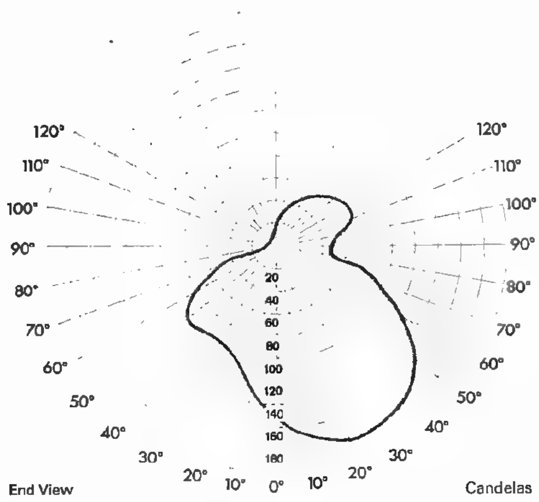
(4) To supplement daylight with artificial light coming from the direction of the windows.

A large installation of these fittings was recently completed in a new Westminster Bank computer centre in the City of London where detailed appraisals were carried out to assess the satisfaction of the staff working in these conditions. The measurements taken indicated that the ratio of average illumination over the unoccupied room to the working illumination on occupied desks was about 2 to 1 which is appreciably better than results with conventional fittings in similar rooms. The luminance pattern produced was considered to be completely acceptable by the majority of those appraising the installation, and generally it was felt that the installation produced the right quality and quantity of light.

Effective—and pleasant to work in

A number of experienced observers commented favourably on the differences apparent to them between this installation and other similar interiors using conventional fittings, without being able to define precisely what it was that made the difference. It appears that this favourable reaction was partly due to the higher wall brightnesses produced by the flow of light across the room, and partly due to the flow of light itself.

Further development work is being carried out to assess the importance of these different factors in the planning of installations that are effective in lighting the working positions and pleasant to work in by virtue of their effect on the room as a whole.



Polar distribution of the Atlas asymmetrical fitting.

the Thorn Q-File lighting control system

by R E Jones CEng FIERE

More than 20 television studios in Britain are now equipped or soon will be equipped with the revolutionary Thorn Q File lighting control system
The BBC, which has had a system in successful operation for nearly two years, has now ordered three further installations. Southern TV, which has been using Q-File for more than a year, has also ordered equipment for another studio. An installation has recently been completed at Granada Television while equipments are also being supplied to Associated Television and the Thames, Yorkshire, Anglia and Scottish companies.
Q-File was briefly referred to in the last issue of *Lighting Journal*. Here R E Jones, who is technical sales manager of BLI's Theatre Lighting Division, explains its method of operation.

The name 'Q-File' was chosen as a title which, with some phonetic licence, expresses concisely the basic function of the equipment. This function is to file, or memorize beforehand, the many lighting changes or cues which can occur during a stage or television studio production. Ideally, it should be possible during rehearsal to plan all states of lighting and their manner of change, and subsequently to recall these changes by a single GO button operation manually synchronized with the action. The Q-File system closely approaches this ideal but retains sufficient flexibility to enable the operator easily to accommodate the inevitable variations which occur 'on the night' during a live production.

The necessity for this computer type approach to lighting control is particularly evident in television studios where the rapid turn around of rehearsals and productions demands the maximum expedition in planning the lighting of shows. In the case of colour television, a high speed electronic memory is of enormous benefit in view of the many and rapid changes of colour balance which can occur during a production.

For similar reasons, the Q-File concept is of immense value in the theatre, particularly in the field of light entertainment, opera and ballet where imaginative lighting is of paramount importance.

Briefly, the Q-File system enables the brightness levels of up to 390 dimmer-controlled lighting circuits to be recorded instantly at any time in one of 100 electronic memory files. These files may be selected sequentially or in random order. Thus the use of all files will provide the choice of 100 independent lighting patterns, each of which can utilize some or all of hundreds of different lighting circuits. These circuits may be at the same or different brightness

Typical Q-File control desk suitable for a 300 dimmer installation.

levels. Any file, i.e., memory, can be recalled instantly, and any number of separate memories can be added to or subtracted from each other with equal ease to produce a composite effect.

The substitution or combination of memories can take place as a rapid switch action, i.e., a cut; or as a crossfade which, when initiated by pushbutton, will proceed automatically in a time which can be adjusted between one second and one hour.

Full scope for imagination

This basic function is augmented by many special facilities, the use of which gives full scope to the imagination of the lighting designer. For example, in a crossfade the fade-up and fade-down time for different lighting circuits can be adjusted independently and the two fade processes can be started separately or simultaneously. A second operation of a start button will interrupt the corresponding fade which can be restarted when required.

It is of interest to note that the time required to complete a fade is the same for all circuits, irrespective of their starting and finishing levels. An important feature of this equipment is that once a fade has been initiated it proceeds automatically, leaving the operator free to introduce other lighting effects. He can, for example, switch on other lighting circuits not included in the fade. A typical practical case is an indoor scene lit by fading daylight seen through a window. The intensity and colour of the simulated daylight changes slowly as an automatic crossfade, and at an appropriate moment an actor may enter and switch on a practical light, e.g., a standard lamp. This lamp, with its associated backing or fill lights, is brought into operation by one button which adds in a memory representing these particular circuits. This addition is independent of the fade process, which still continues to run, and the added lights can be subsequently switched off again if required.

Alternatively, in a different application, a memory can be added in as a continuation of the fade. For example, a night-to-dawn transition can be culminated by a realistic impression of sunrise as a later and overlapping stage of fade. Separate fade-up and fade-down meters indicate the percentage completion of a fade at any time and enable the introduction of special effects to be correctly related to the main lighting level.

Even those circuits involved in a fade can be instantly removed from the fade process and placed under manual control. For example, an incorrectly positioned lamp can be manually faded out without affecting the other lights which are subject to the automatic fade.

Because of the independent fade facilities and the ability to add and subtract any number of individual memory files, the effective memory capacity for lighting cues is considerably in excess of 100. Also, although 100 files have been adopted as standard, there is no reason why this number should not be increased if this is felt to be necessary in a particular case.

All the basic operations described above can be readily understood and easily carried out by the most inexperienced lighting operator. The more experienced man will appreciate that the many independent variables give him almost unlimited scope for imaginative lighting effects unattainable with any other known control system.

The special purpose computer

Figure 1 shows in block form the main functional elements of the system. The centre block, labelled Memory Files, represents the permanent record of lighting data. The blocks on either side represent electronic stores containing data in use; this can be copied into or out of the files.

These stores are named as the Studio and Preset store respectively. The data in the Studio store directly controls the dimmers and therefore determines the actual lighting situation at any time. The Preset

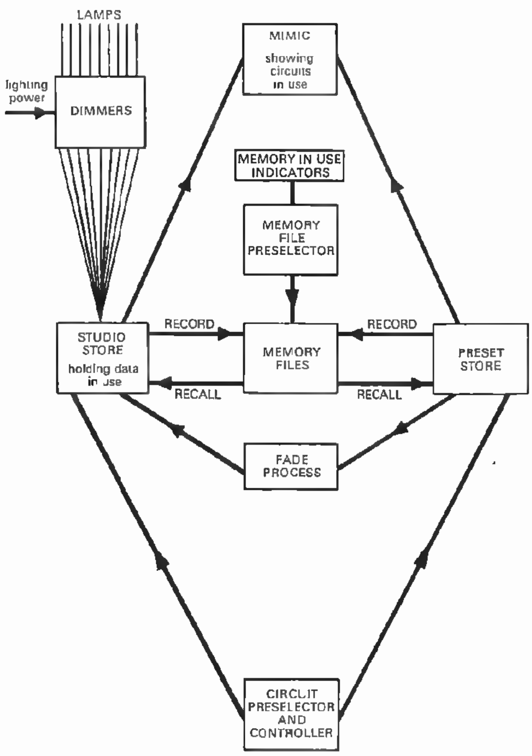


Figure 1 Block diagram of the main functional elements.

store does not normally have direct control of the dimmers but provides a number of functions which will be explained later.
To set up a lighting scene the circuit controller is used to feed electronic data representing circuit ON/OFF states and levels into the Studio store. Since this store has direct control of the dimmers, the operator's actions are immediately manifest as a growing pattern of lighting. This may be permanently recorded at any time simply by selecting one of the 100 memory files and copying the store data into this by pressing the Studio RECORD button.
The switching on of any lighting circuit illuminates a correspondingly numbered window in a mimic diagram which therefore provides a clear indication of which lighting circuits are in use at any time.
Once the state of lighting has been recorded, i.e., copied into a memory file, the existing Studio store data can be cancelled and a new lighting scene developed and memorized. Alternatively, it may be advantageous to record variations of the original scene in separate memory files in order to choose the optimum artistic effect. Since the alternative memories can be instantly recalled in turn, comparisons of this kind are extremely easy and this feature represents one of the major advantages of the Q-File system.

Three ways of instant recall

The instant recall of any memory can take place in three different ways:

(a) By a 'cut' action which replaces the original store data with that represented by the new file.

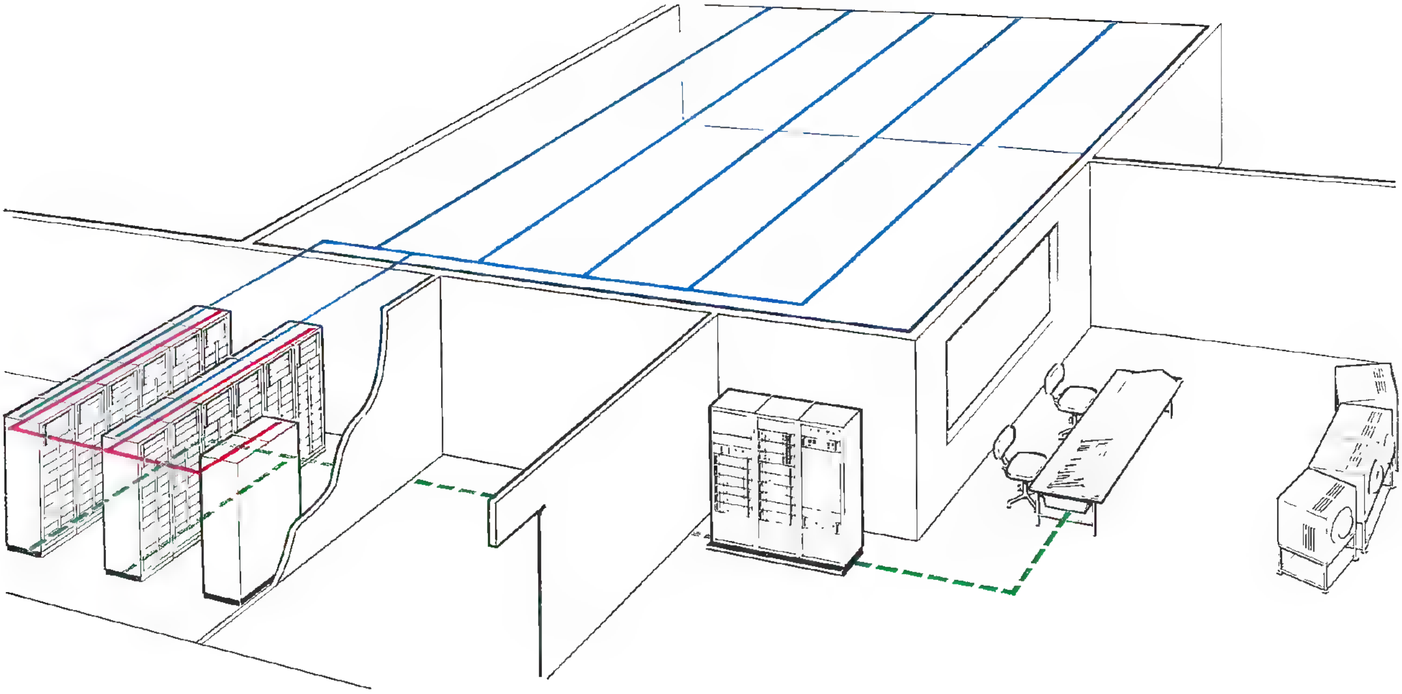
(b) By a 'plus' action which adds any new lighting circuits represented in the new file and substitutes new levels for circuits which are already in use.

(c) By a 'minus' action which switches off all circuits represented in the new file.

It may be appropriate on occasion to retain an original pattern of lighting for use during a rehearsal but at the same time to plan the next lighting cue in advance. This can be done by retaining the Studio store data and using the circuit controller to feed data into the Preset store.
Since this store does not directly control the dimmers, the existing lighting is not disturbed. However, the mimic diagram can also display the ON/OFF state of circuits represented in the Preset store and the operator is able to include data representing their brightness level by use of his calibrated fader control. When completed, this 'blind' plot may be recorded and the corresponding memory file can be subsequently 'cut' into the Studio store for use and live adjustment. Operation of the Studio store RECORD button will then modify the original memory to correspond to the corrected lighting.

Key role during a fade

Apart from its use as an electronic notepad for the blind plotting of future cues, the Preset store also provides the means for examining and (if necessary) modifying existing memories without disturbing lights already in use. However, the most important role of this store occurs during a fade, when it is fed with information representing the state of lighting required at the end of the fade. This data will normally result from 'cutting', i.e., copying the next memory file into this store. When the fade is initiated, the original Studio store data changes to match that in the Preset store in a time determined by the setting of the fade duration controls.
It is important to note that during a fade the only circuits which will change are those for which new data exists in the Preset store. Circuits represented as OFF in the Preset store will remain unchanged. Thus in a crossfade where original lights have to be extinguished it is



necessary to represent these circuits as ON at zero level in the Preset store. This occurs automatically whenever the CROSSFADE button is depressed. A 'remainder zero' action is not always required and in this case the desired effect can be achieved by the simultaneous depression of two separate UP FADE and DOWN FADE buttons. Used individually, these two buttons enable simple up and down fades to be initiated independently if required.

Figure 2 Typical disposition of equipment in a television studio. The control cables shown in green can have a length of up to 150 ft. between the control panel and the control racks, and 250 ft. or more between the control racks and the dimmers. The red lines represent the incoming lighting power while those shown in blue depict the cables to the individual luminaires.

Automatic sequence facility

The incorporation of an automatic sequence facility provides a further simplification of control. Provided that the memory files are programmed in numerical sequence, use of this facility automatically preselects the next file whenever the preceding file is recalled for use. It is then possible to light a straightforward multiple cue production by operating no more than two buttons for each cue, coupled with adjustment of the fade duration levers. While a fade is in progress, new data can be added to, or subtracted from either store, using either the circuit controller or the memory PLUS and MINUS buttons. In the case of the Studio store, the added data becomes immediately effective as actual lighting. Thus, in the example referred to earlier, a day-to-night crossfade can be initiated and at some stage a practical light and its associated fill lights can be brought into use by adding a memory representing these lights to the data already in the Studio store. This added data is not affected by the fade process. In the event of the added data representing circuits which are already fading, these circuits are automatically excluded from the fade and immediately brought to the level represented in the added memory.

If the new data is added to the Preset store it becomes effective as a continuation of the fade and will be completely matched in the Studio store in the time set by the fade duration controls.

Notwithstanding its automatic electronic functions, Q-File retains various means of manual control familiar to operators of conventional systems. Individual circuit levels are adjusted by means of a quadrant fader in the usual way and a pair of master faders provides overall control of the lighting represented by the Studio store and Preset store data respectively. The operation of a MIX STUDIO/PRESET button enables both stores to control the lighting simultaneously, thus

providing a situation analogous to the conventional two-scene, two-master control board with manual crossfade.
A further manual control facility is offered by an auxiliary control panel. In its standard form this mounts ten manual faders, each of which, by means of a miniature patch panel, can be given control of any lighting circuit or combination of circuits. The association of circuits and faders is simply a matter of inserting small plugs into the appropriate holes in a plug matrix. These auxiliary faders can be given control of any lighting circuits which, for some special reason, are best manipulated by direct manual means, e.g., follow spots, orchestra lights, etc. Also, should a failure ever occur in the electronic control system, a previously established emergency lighting plot can be immediately brought into use by means of a single fader.

The control console

Apart from functional limitations, traditional lighting control boards have very frequently raised problems of location due to the need to accommodate possibly several hundred individual fader control levers. This 'one fader for each circuit' concept presents a further problem when memories, including circuit levels, are also involved. This is due to the fact that whenever a previously prepared memory is recalled for manual readjustment it is almost certain that the present settings of the faders will differ from those which were used in setting up the earlier memory. Thus the resumption of manual control must in some way include a matching action between each fader and its previously memorized level.
In Q-File both space and matching problems have been solved by the use of a single servo-controlled fader which can be 'addressed' to any circuit or group of circuits by means of a set of decimal coded preselector pushbuttons. This approach enables all basic controls to be mounted on a panel less than two feet square, and enables the most complex lighting manipulations to be carried out by a single, comfortably seated operator.
Figure 3 shows a typical panel arrangement. On the right hand side is the servo-fader adjacent to the circuit preselector buttons. Opera-

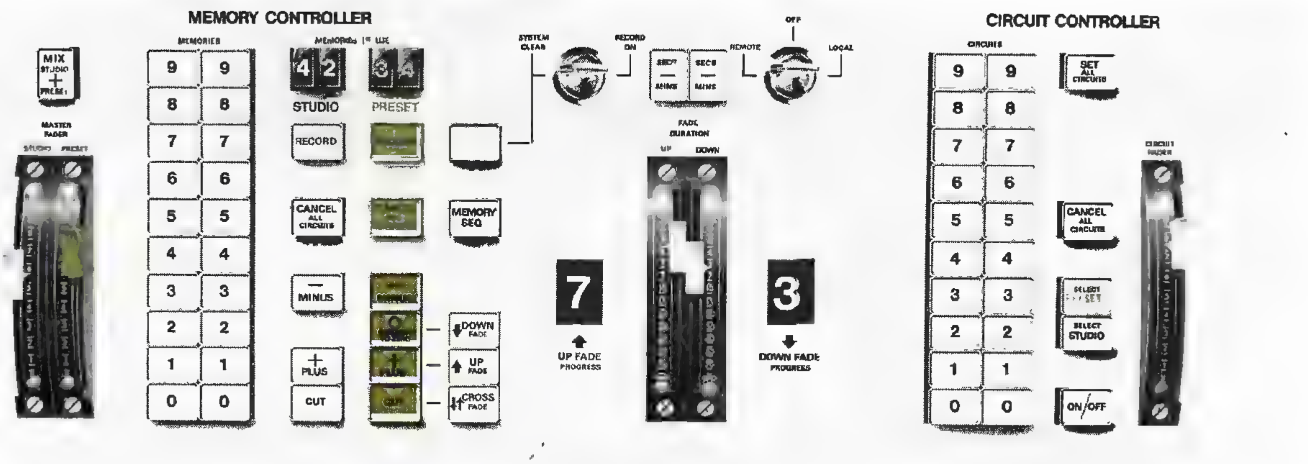


Figure 3 A typical Thorn Q-File control panel layout

tion of the appropriate buttons in the hundreds, tens and units columns enables the operator to assume control of any circuit or group of circuits. At the beginning of a lighting exercise some convenient starting level for all circuits can be predetermined by use of the servo-fader and the SET ALL CIRCUITS button. Individual circuits may then be preselected and switched on by use of the ON/OFF button (alternate operations of this button switch the preselected circuits on or off).

Immediately a circuit number is preselected, the servo-fader will move automatically to the level represented for this circuit in the store at that time. If the operator now takes hold of the fader lever, an automatic sensing device disconnects the servo drive and enables the preselected circuit to be manually readjusted in a perfectly normal manner. On releasing the control lever, the servo drive is reconnected but the fader retains its new setting, since this is already matched by a corresponding level in the store.

Thus, by a process of successive circuit selection and adjustment, the desired state of lighting is achieved, and this is represented electronically in the Studio store in terms of circuit ON/OFF states and levels. A 'blind' plotting exercise can be carried out in the Preset store in exactly the same way.

Different colours show state of stores

As previously stated, circuits represented as ON in the stores are at all times indicated by the illumination of numbered windows on the mimic diagram. Different colours are used to show the state of the Studio and Preset stores; in the case of the Studio store, it can be arranged that the brightness of the mimic lamp provides an approximate indication of the level of the corresponding circuit. An accurate indication of the level can always be obtained from the servo-fader which automatically positions itself to correspond to the level of the circuit which has been preselected. The significant preselector buttons are at all times indicated by internal illumination.

The rest of the panel carries the master controls. These include the memory file preselector buttons and the RECORD CUT, PLUS and MINUS buttons for each store. In the case of the Preset store, a button labelled CIRCUITS TO ZERO is also provided. This is necessary since a fade-out action requires that the circuits concerned be on at zero level in the Preset store, as previously explained. Also included are the fade controls comprising the CROSSFADE button, the individual UP and DOWN fade buttons and the fade duration control levers. A second operation of any fade-initiating button stops the original action, enabling any stage of fade to be interrupted and, if necessary, resumed at the interrupted level by a third operation of the same button. Each button is internally illuminated while the corresponding stage of fade is in progress. The fade duration control levers are calibrated 0 to 70, which figures can represent seconds or minutes as determined by operation of the range buttons. The end stop position is marked as infinity, and returning the levers to this position provides an alternative method of stopping the fade, or manually delaying its start.

The master control panel also mounts the two master faders and the MIX STUDIO/PRESET button which gives the Preset store temporary direct control of the dimmers. The CANCEL ALL CIRCUITS buttons switch off all circuits in their related stores but do not cancel the stored dimmer levels. These latter may be reset individually or collectively by use of the SET ALL CIRCUITS button.

Above the two sets of action buttons are a pair of double window digital indicators which display the number of the last memory file recalled for use in either store by means of a 'cut', 'plus' or 'minus/zero' action. Where recall is by means of a crossfade, the Studio store

Figure 4 Portable control unit. Attached to a flexible cable, this enables all the principal control functions to be carried out from a convenient position on the studio floor.

indicator will initially display the file number corresponding to the lighting at the start of fade, whereas that for the Preset store will display the file number representing the end of fade situation. On completion of the crossfade, the Studio store indicator will change to correspond to that for the Preset store.
Elsewhere, two larger windows display numbers changing from 0 to 10 as the corresponding stage of fade progresses.

Control equipment

This is normally housed in three or possibly four 19in racks mounting individual sub-units employing printed card assemblies. These racks may be located several hundred feet from the control panel and dimmers and, because of the very low internal heat dissipation, no special ventilation is necessary.

Dimmers

These are of the thyristor type designed to a very rigid specification. Current types have power ratings of 2kW, 5kW, and 10kW. The efficiency of these dimmers is 98% of their full load rating and special consideration has been given to their stability, enabling individual dimmers to be interchanged without introducing output voltage variations of more than about 1%.
The control circuit provides a basically square law relationship between control voltage and light output when using tungsten lamps.
A degree of compensation for mains voltage variations is incorporated, enabling this to be reduced by about 50% over most of the control range.
Each dimmer includes a specially designed filter choke which minimizes lamp sing and sound circuit interference by limiting thyristor current rise time to a minimum of about 0.8msec. This is very important where microphone cables have to be run in proximity to lighting power wiring.
Both 5kW and 10kW dimmers have the same physical dimensions (8in $\times 5\frac{1}{4}$in $\times$ 15in) and plug into cabinets accommodating twenty 5kW units or any mixture of 5kW and 10kW dimmers having a total power handling capacity not exceeding 100kW. Alternatively, one cabinet will accommodate thirty 2kW dimmers. The dimensions of these cabinets are approximately 2ft $\times$ 2ft $\times$ 6ft high and each cabinet is fitted with a fan and filter which can be omitted if forced underfloor ventilation is provided. If sufficient airflow is available, an input air temperature as high as 40°C can be tolerated.

Electronic principle of the system

The Q-File system employs semiconductors throughout and includes no moving parts or electro-mechanical devices other than the panel controls. All data processing and memorizing is by digital means, using magnetic core stores and well-established computer type techniques. The two stores use core memories associated with registers which enable the core store information to be sequentially read out, modified if necessary and rewritten. The files employ magnetic core memories into and out of which the stored information can be copied.
Channel information is initially set up in terms of an 8-bit word which includes the ON/OFF state and 80 discrete brightness levels. This data is filed as a 5-bit word on a 20 step basis, permitting recall of the original information within a maximum non-cumulative tolerance of $2\frac{1}{2}$% of full brightness. All 80 steps are employed during a fade between filed levels.
The design of the equipment makes provision for duplex operation of the data storage system. This enables two studios or stages to share

Figure 5 On the left are two racks each containing twenty 5kW dimmers. The three cabinets on the right contain the magnetic memory and electronic control equipment.

common control equipment but at the same time to retain complete operational independence. Duplex operation offers obvious economies in capital cost where two separate studios are physically adjacent.
The functions described do not by any means exhaust the possible applications of the equipment. For example, the position of colour change wheels might be memorized and included in a file. Also, the memorized data need not be restricted to lighting and, in the case of a television studio, could include routing instructions for video and sound circuits, selection being under the control of the appropriate engineer.

Conclusion

The Q-File system can be simply summarized as a means by which the normal processes of stage and studio lighting can be performed with extreme ease, speed and accuracy. Because of the many independent facilities, it also provides a means of achieving lighting effects which are impossible with other types of system. Even so, it is not claimed that this equipment represents the limit of what can be achieved by modern methods. Operational needs are still being studied and, particularly in the case of the theatre, still further improvements in control techniques can be anticipated.
As might be expected, the purchase cost of the Q-File system is higher than that of conventional equipment. However, this initial investment is adequately rewarded, since, in addition to allowing a new freedom in exploiting dramatic lighting, the Q-File approach improves operational efficiency and therefore reduces production manhours. Furthermore, the purely electronic concept avoids mechanical wear and tear and eliminates the need for costly routine maintenance.

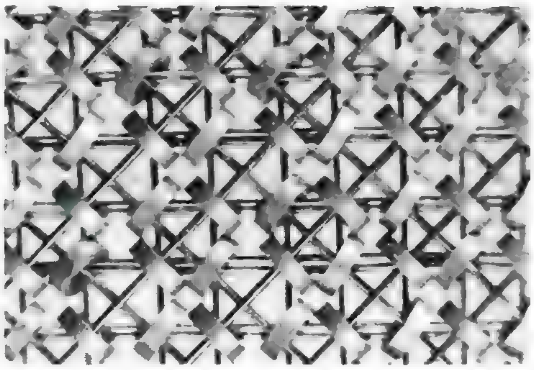


Figure 6 The magnetic core memory.
Each element in the magnetic memory consists of a toroid or core of magnetic material having an outside diameter of 0·05in and threaded with four wires. Many thousands of these cores are assembled as a compact matrix.
Individual cores can be magnetized in the clockwise or anti-clockwise direction by passing a pulse of current through certain of the linking wires. This magnetic state will persist until reversed by a current pulse in the opposite direction
Data is 'written into' the memory by magnetizing particular cores in a given direction representing the '1' state while the remainder are left in the opposite or '0' state. The memorized data is 'read out' by collectively magnetizing all cores in the '0' state which, of course, involves a reversal of the magnetic flux in such cores as were previously in the '1' state.
Each core has its own sensing wire, and a flux reversal causes a current pulse to appear in this wire, enabling the original data to be recovered for use.
Since the 'read' process causes all cores to revert to the '0' state, provision is made for the memorized data to be automatically 're-written' after each 'read' cycle.

Acknowledgement is made to the *Royal Television Society Journal* (Vol. 11 No. 12) in which an earlier version of this paper appeared

metrication in the lighting industry

by Gordon V McNeill CEng MIEE FIllumES

part ii: the problem

This is the second of three articles dealing with the British Government's programme for metrication, with special reference to the activities of the British Standards Institution on Metric Co-ordination and its probable effect on the lighting industry.
Mr McNeill is Technical Training Manager at the new BLI training centre at Leicester.

The most important terminal date included in the programme diagram given in Part 1 of this article is that for the construction industry, which aims at completing the main changeover to metric by the end of 1972. The basic programme is summarised in Table 1 and shows the ten categories of action outlined in BSI programme PD.6030. Manufacture of metric products is covered by categories 4 to 7 of the programme, in order of metric importance, and BSI work on dimensional co-ordination has been arranged to deal with each item in order of priority. For example, suspended metal ceiling grids are in category 4, modular lighting fittings are in category 5 and non-modular lighting fittings are in category 6.

Item	1:	Time to produce the programme(published February 1967)
	2:	Time for BSI preparatory studies (1967/68)
	3:	Time for essential reference publications (1967/69)
Item	4:	Make products essential to dimensional co-ordination (1970/73)
	5:	Make products dimensionally related to Item 4 (1970/73)
	6:	Make products not dimensionally related to Item 4 (1970/73)
	7:	Make products only needing sensible metric sizes (1970/73)
Item	8:	Time for metric calibration of measuring instruments (1968/70)
	9:	Time for metric contracts and drawings to be designed (1969/72)
	10:	Time for contractors to change to Item 9 contracts (1970/73)

Table 1 Categories of change-over action

A further BSI programme guide has recently been issued for the electrical industry (PD.6427: 1969), which separates equipment into five sector timings, of which lighting fittings are included in Sector 2. This allows for design work to begin in January 1969 and to increase from 25% to 75% of all new designs between 1970 and 1972. Production of metric module size lighting fittings is scheduled to begin in January 1970 and to increase from 25% to 75% of total production between 1971 and 1974, thus extending to a later period for 75% completion than in the construction industry. For large construction

projects it seems reasonable to assume that metric building problems and material demands may need to be dealt with a year or more ahead of the final services, including lighting, but the dates given in the two programmes give very little time for complete metric conversion of lighting equipment production.

Controlling dimensions in building

Basic sizes for metric modules were established in BS.4011 at an early stage, recommending 300mm as the first preference module for basic spaces in metric construction with 100mm as the second preference module. Comments received by some user and manufacturing associations have indicated that there is a preference for multiples of 600mm as the basic space module, particularly for horizontal controlling dimensions.

The Ministry of Public Building and Works has already issued a report, 'Going Metric', which indicates its intention to change to metric construction for all Government projects between 1970 and 1973 and, since Government construction work is about half the total building carried out in Britain, this could influence construction generally. It seems likely, therefore, that a large proportion of building projects now being designed will be based on metric modular dimensions and this demand will encourage manufacturers to make metric product ranges available within the next year or two. The Engineering Equipment Users' Association has also issued a report which recommends a general changeover to metric components by its members between 1970 and 1975, with the major changes taking place around 1972. This means that manufacturers must start work on metric engineering equipment now if they are to meet this expected demand. An indication of the growth of metrication is that the International Building Exhibition at Olympia (London) in November 1969 will be designed, specified, quoted for and constructed throughout in metric units.

Basic spaces for building sub-division

The Ministry of Public Building and Works has issued a number of reports on metric dimensional co-ordination in buildings (DC1 to DC6) based on multiples of the 300mm first preference module in BS.4011, and these reports have contributed to the recently issued BS.4330 specification which gives recommended metric dimensions for building construction. These controlling dimensions produce a modular grid of 'basic spaces' and 'zones' for both the vertical and horizontal planes of the building, the latter being of particular importance to the lighting industry.

Figure 1 shows how the vertical controlling dimensions can be classified as (A) the effective floor to ceiling height plus (B) the ceiling void and floor thickness, which combine to give the overall floor to floor height (C).

For the horizontal plane, two alternative methods are permissible in BS.4330. These are referred to as Method A, which allows for an axial grid into which the supporting columns and walls trespass, or Method B which allows for zones to be inserted between the basic spaces. These alternatives for horizontal controlling dimensions are shown in Figure 2 and it is necessary to assess the relative advantages and disadvantages of each method at an early stage in the building design. For example, Method A would be preferable for large open-plan areas because the continuous grid of basic spaces would more than off-set the problem of installing the ceiling system round the corners of supporting columns. Method B could be preferable for an

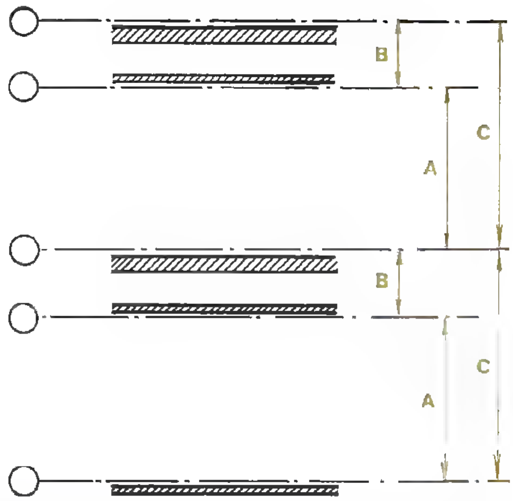


Figure 1 Vertical dimensions for basic spaces

(A) Floor to ceiling:
2 400 to 3 600mm (in 300mm steps*)
2 300 to 2 900mm (in 100mm steps)
Heights over 3 600mm in multiples of 600mm (first preference)
(B) Floor roof zones:
100 to 600mm (in 100mm steps*)
*Spaces over 600mm in multiples of 300mm (first preference)
(C) Combined (A + B):
2 700mm or more* (in 300mm steps)
*Height of 2 600mm acceptable for housing purposes

area where considerable sub-division with walls or partitions is to be carried out and where zones of say 100mm can be inserted between the basic spaces (see Figure 2).
The likelihood of multiple sub-division of horizontal areas must therefore be considered at an early stage in the building design, because the trespass of partition thicknesses into basic spaces could seriously limit the choice and size of lighting equipment. It is also possible that both Methods A and B could be used in different sections of the same building.

BS.4330 controlling dimensions

Wherever possible, BS.4330 controlling dimensions are based on the first preference BS.4011 module of 300mm for spacing between zones, with the second preference 100mm module permitted for zone widths of walls and columns.
As previously mentioned, the vertical dimensions are defined as A, B and C which cover the floor to ceiling height and/or the zone between floors. For most normal interiors the minimum floor to ceiling height is 2 400mm with increased heights in multiples of 300mm. Although the vertical dimension has some effect on the lighting layout in regard to the mounting height and spacing of fittings, it is not as critical on dimensional co-ordination of lighting equipment as the horizontal basic space.
Figure 2 shows that the horizontal controlling dimension for spacing between zones has a minimum value of 900mm with increases in steps of 300mm. Comments received from some ceiling grid manufacturers and large users have indicated a preference for multiples of 600mm which would give basic spaces of 1 200, 1 800, 2 400 and 3 000mm et seq. When Method B is used, the width of the zone for columns and load bearing walls should be in 100mm multiples, with a preference for 300mm multiples. The footnote to Figure 2 draws attention to comments from manufacturers that the first practical preference for the thickness of non-load bearing partitions is 50mm, i.e., the equivalent of 2in partitions.
For industrial buildings, the preferred basic space modules and trunking lengths are 3 000 or 4 500mm and these modules are not likely to create any special problem with regard to metric size lighting fittings, since the most efficient 8ft tube lengths can be used with a 3 000mm basic module. A problem does exist, however, in commercial buildings where smaller basic spaces are used and where modular fluorescent lighting fittings are required to fill exactly each of these spaces.
The third (and final) part of this article will show how the problems of metric modules for building construction can be solved, for the lighting of both industrial and commercial buildings.

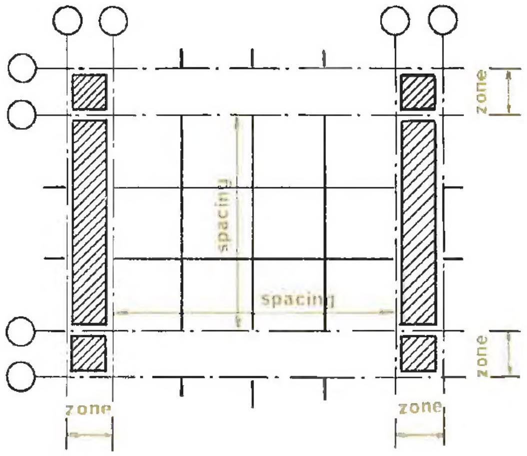
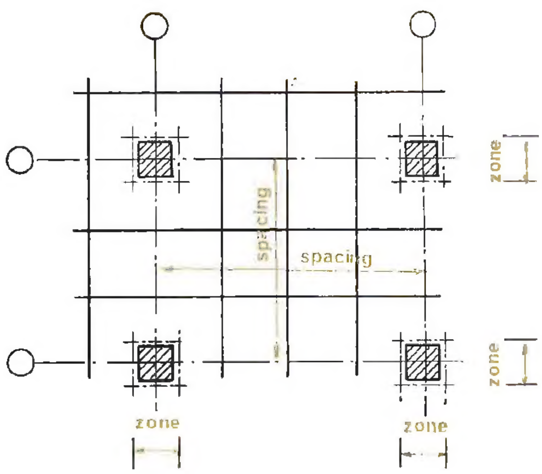
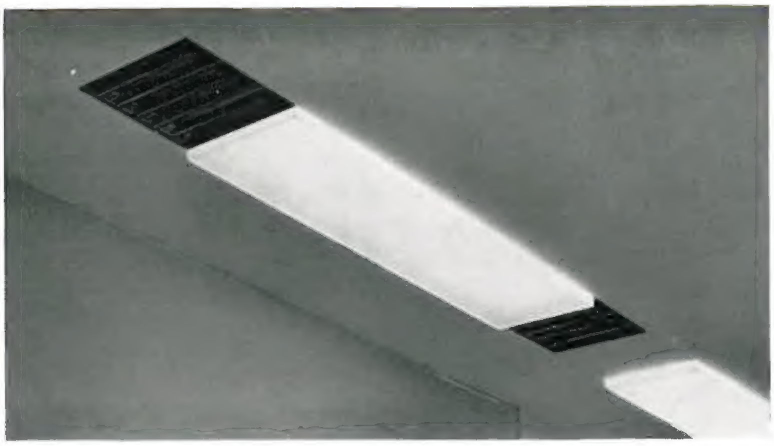


Figure 2 Horizontal dimensions for basic spaces: Method A above, Method B below

Spacing between zones:
900mm or more (in 300mm steps*)
*First preference for multiples of 600mm
Width of zones:
100 to 600mm (in 100mm steps*)
*Zones over 600mm in multiples of 300mm (first preference)
Note 1: First practical preference for partitions = 50mm thickness
Note 2: Industrial building modules = 3 000mm or 4 500mm



an Atlas airhandling design



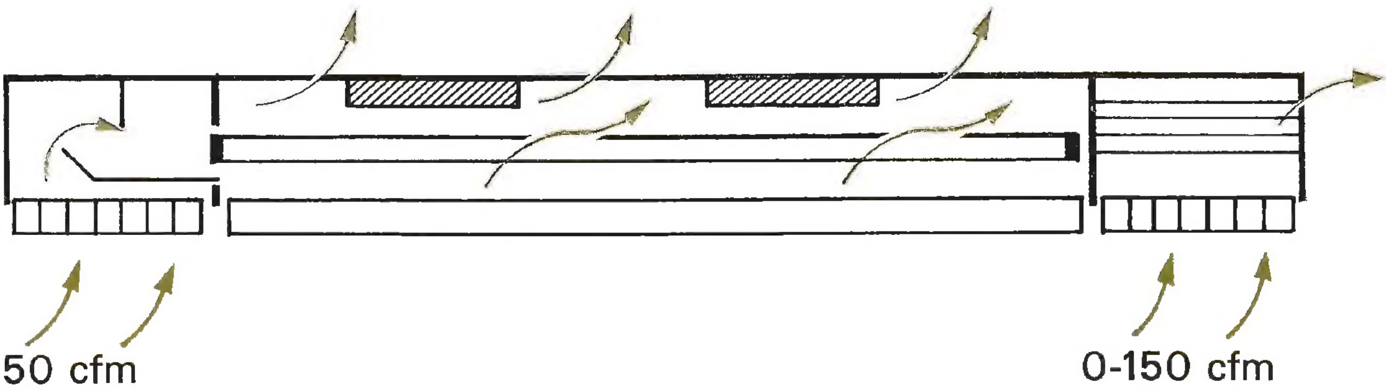
In the Phase Two buildings for the University of Surrey the need for maximum space flexibility called for the integration of lighting fittings with both the ceiling system and the mechanical ventilation system. A special airhandling fitting was therefore decided upon by Building Design Partnership, London, and developed by BLI, the successful tenderers.

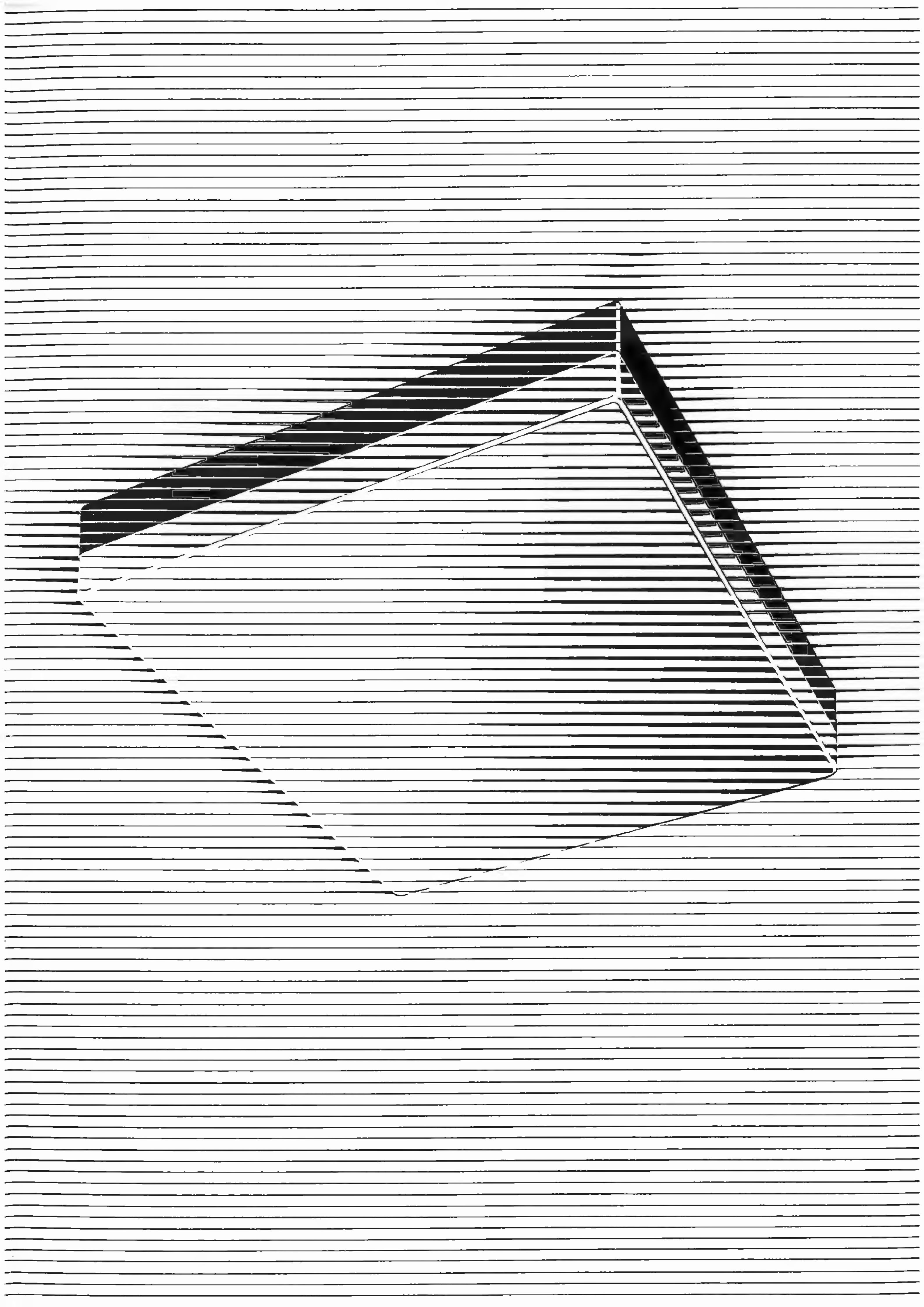
The technical specification for the fitting included lighting, airhandling and acoustic factors, as follows: the fitting was to be designed for use with either two or three 4 ft. 40W fluorescent tubes, with dished prismatic control, a light output ratio of at least 50% and a BZ3 classification. The fitting was to handle 200 cfm of air, and the room-to-room cross talk attenuation was to be 30dB av.

Basically the fitting is 4 ft x 1 ft and designed to fit into the Burgess ceiling. This basic fitting can be converted into an airhandling fitting by adding boxes to one or both ends (*Fig. 1*). This design was necessary because of the need to handle 200 cfm of air at a fitting resistance of 0.015 in WG. This volume of air, if passed through the lamp compartment, would overcool the lamps and reduce their light output. The airflow through the fitting is therefore designed to split along two paths: 50 cfm of air is handled by one box which allows the air to enter into the lamp compartment, the extract slots being situated directly above the lamps and control gear in three rows. The remaining 150 cfm is handled by the box at the other end of the fitting and this air does not enter the lamp compartment.

It is not easy to combine high noise attenuation and low fitting resistance, but by careful design of the air flow paths, including vertical vanes to change the direction of flow and absorb some of the transmitted sound, a noise reduction index of 35 dB av. is achieved in the final fitting.

Figure 1 Longitudinal section of fitting showing air flow paths





THE QUEEN'S AWARD
TO INDUSTRY 1968
TO ATLAS LIGHTING LIMITED